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D6.8 – Thermal and Acoustic characterisation of BRIMEE ECO-innovative Panels

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Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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1 Introduction

This document is the Deliverable 6.8, which is dealing with thermal and acoustics characterisation of BRIMEE ECO-innovative panel, in the framework of the BRIMEE project.

The most important features of BRIMEE ECO-innovative panel are related to the insulation core of the whole structured composition. With the characterisation of the insulation core, BRIMEE NCC white foam, indicative values of performances for the BRIMEE ECO-innovative panel are given. For this reason, the tests for thermal and acoustics characterisation have been performed on the insulation core of BRIMEE ECO-innovative panel, BRIMEE NCC white foam.

In Chapter 2, testing procedures, analysis and results of thermal characterisation of the samples are described, according to standard measurement methodology described in SIST EN 12667:2002.

In Chapter 3, testing and analysis of acoustic characterisation of the samples according to standard measurement methodology SIST EN ISO 10534-1: 2002 are given.

The above mentioned activities were performed in Department for Building Physics, at Slovenian National Building and Civil Engineering Institute (ZAG). The procedures included thermal conductivity measurements and measurements for determination of sound absorption coefficient on BRIMEE NCC white insulation samples delivered to ZAG in August 2016.

2 Measurement of thermal conductivity on BRIMEE samples

2.1 General

Thermal properties of building materials and products need to be determined according to measurement methods set up in the standards. For BRIMEE ECO-innovative panel, the characterisation of the insulation core, which is BRIMEE NCC white foam, is the most important since it gives the indicative value of the thermal performance of the entire BRIMEE ECO-innovative panel.

The availability of preliminary material samples of BRIMEE NCC foam enabled ZAG to perform preliminary measurements and determine the thermal conductivity. The samples of two batches were included in these tests: batch from May 2014 and batch from January 2015. Details about these tests have been included within deliverable 6.4 “Thermal and Acoustic characterisation of BRIMEE eco-innovative panels”. Moreover, in August 2016 the last batch of BRIMEE material was delivered. All the activities performed on this batch of material are described in the following paragraphs.

2.2 The measurement procedure and the method

Measurements of BRIMEE material from batch August 2016

The samples of BRIMEE material from batch of August 2016 were in form of two light white boards. The panels made available from SILCART to perform the tests of sound absorption and thermal characterization belong to a batch for which some problems of drying occurred. The structure of the bulk of the samples resulted to be representative of the panel materials, but the dimensions and surface were out of the standards achieved within other production batches (Figure 2.1). For these reasons, they have not been implemented into the demo, and have been employed for tests and trials (either non destructive, as the ones described within this deliverable, and destructive as the ones in D6.7). The material has quite low density.

Table 2.1 Dimensions of BRIMEE samples from batch “August 2016”

	a [m]	**b** [m]
BRIMEE board 1	0.575	0.365
BRIMEE board 2	0.330	0.370

The boards were used as samples for measuring the thermal conductivity according to SIST EN 12667:2002, by means of the heat flow meter method.

Figure 2.1 Two boards of BRIMEE samples from batch August 2016.

The experimental setup is a heat flow meter (HFM) apparatus with single specimen configuration (Figure 2.2). The apparatus is intended to establish an unidirectional constant and uniform density of heat flow rate. It is therefore divided into a central metering section in which the measurements are taken and a surrounding guard section. It has the fluid tempered hot and cold side and operates at temperature difference 6-7 K across the specimen with the mean temperature approximately 12°C. The full size of the specimen in this setup can be 800 x 800 mm. Due to sample size, which was roughly 250 X 350 mm, the HFM apparatus was not fully covered with the sample. The metering area itself was, however, fully covered with the sample and the sufficient guard was provided. The heat flow rate is measured by means of one or two heat flow meter(s) placed against the specimen. The thermal resistance of specimen, R, is calculated from measured density of heat flow rate, q, the metering area of specimen, A, and temperature difference, ΔT. The thermal conductivity, λ, is calculated from thermal resistance, R, and the thickness of the specimen, d.

Figure 2.2. Sensors of the HFM apparatus for measurements of thermal conductivity

The measurements were executed from 16th November 2016 till 18th November 2016.

Samples designation in the laboratory:	BRIMEE TB/16
Type:	BRIMEE NCC White Board
Form:	Two pieces of white boards (flexible)
Sample designation:	BRIMEE, batch August 2016
Surface treatment:	Surface retained
Temperature of the surrounding:	23°C ± 5°C
Air humidity during the test:	50 %rH ± 30 %rH
Product standard:	Not applicable
Sampling protocol:	-
Conditioning:	Laboratory conditions > 7 days
Temperature during conditioning:	23°C ± 3°C
Relative air humidity during conditioning:	50 % rH ± 10 % rH

The measurements were done according to SIST EN 12667:2002, HFM method. During the test the specimen was installed horizontally. Temperature difference was measured with T-type thermocouples; Heat flux was measured with 2 calibrated heat flux plates, installed in the machine.

2.3 Results of the measurement and analysis

SAMPLE 1

Dimensions:	0.370 m × 0.330 m
Mass change during the measurement:	No change.
Apparent density ✕ρ:	69.2 kg/m^3
Thickness d:	9.25 mm

Table 2.2. Results of the HFM measurements for BRIMEE sample 1

Mean temperature [°C]	Temperature difference [K]	Heat flux density [W/m^2]	Thermal resistance [m^{2}K/W]	**Thermal conductivity [W/mK]**
11.20	7.93	31.53	0.252	**0.037**

SAMPLE 2a

Dimensions:	0.575 m × 0.365 m
Mass change during the measurement:	No change.
Apparent density ✕ ρ:	50.3 kg/m^3
Thickness d:	8.3 mm

Table 2.3. Results of the HFM measurements for BRIMEE sample 2a

Mean temperature [°C]	Temperature difference [K]	Heat flux density [W/m^2]	Thermal resistance [m^{2}K/W]	**Thermal conductivity [W/mK]**
11.14	7.62	31.36	0.243	**0.034**

SAMPLE 2b

Dimensions:	0.575 m × 0.365 m
Mass change during the measurement:	No change.
Apparent density ✕ ρ:	47.9 kg/m^3
Thickness d:	8.8 mm

Table 2.4. Results of the HFM measurements for BRIMEE sample 2b

Mean temperature [°C]	Temperature difference [K]	Heat flux density [W/m^2]	Thermal resistance [m^{2}K/W]	**Thermal conductivity [W/mK]**
11.36	7.86	31.56	0.249	**0.035**

CALCULATED AVERAGED VALUE

Apparent density ✕ ρ: 55.8 kg/m^3

Thickness d: 8.8 mm

Table 2.5. Results of the calculated averaged value for BRIMEE samples

Mean temperature [°C]	**Thermal conductivity [W/mK]**
11.23	**0.035**

According to laboratory measurements and analysis of the treated thermal insulation, BRIMEE white foam from batch of August 2016, has a thermal conductivity of 0.035 W/mK with standard deviation of 0.003.

3 Measurement of sound absorption coefficient of BRIMEE samples

3.1 General

The protection against noise in buildings is getting more and more important. Therefore, building materials and products need to be tested according to measurement methods set up by the standards. In BRIMEE ECO-innovative panel, the insulation core, made with BRIMEE NCC white foam, plays an important role. Indicative value of the noise protection can be given by the measurement of its sound absorption coefficient.

The availability of preliminary material samples of BRIMEE NCC foam enabled ZAG to perform preliminary measurements of sound absorption coefficient. The samples of two batches were included in these tests: batch from May 2014 and batch from January 2015. Details about these tests have been included within deliverable 6.4 “Thermal and Acoustic characterisation of BRIMEE eco-innovative panels”. In August 2016 the last batch of BRIMEE material was delivered. All the activities performed on this batch of material are described in the following paragraphs.

3.2 Description of the samples and the measurement method

Measurements on BRIMEE material from batch August *2016*

From batch of BRIMEE insulation boards received in August 2016, six (6) samples were cut for the measurements of sound absorption coefficient (Figure 3.1). The shape of the samples was round with the diameter 88 mm and 36 mm.

Figure 3.1. BRIMEE samples from batch August 2016

Measurement method is the following: determination of sound absorption coefficient in impedance tube using standing wave ratio, according to the standard SIST EN ISO 10534-1:2002.

The samples were inserted into the impedance tubes with a diameter of 88 mm and 36 mm in such a way that there was no air gap between the base surface of cylindrical samples and the bottom of the tube.

Two impedance tubes, made of 4 mm thick steel, were used:

- 100 cm long with an inner diameter of 88 mm for measurement in the frequency region between the third-octave band 250 Hz and the third octave band 1000 Hz and
- 28 cm long with an inner diameter of 36 mm for measurement in the frequency region between the third-octave band 1250 Hz and the third octave band 5000 Hz.

A microphone with the probe tube was used. A correction for tube attenuation has not been applied.

The measurements were executed on 9th November 2016.

Samples designation in the laboratory:	BRIMEE A60/16
Type:	BRIMEE white board
Form:	3 samples of diameter 88 mm
	3 samples of diameter 36 mm
Thickness:	10 mm
Sample designation:	BRIMEE batch August 2016
Temperature of the surrounding:	21 °C
Air humidity during the test:	32 % rH
Air pressure:	997 hPa

3.3 Results of measurement and analysis

Table 3.1. Measured sound absorption coefficients of BRIMEE, batch August 2016

Frequency (Hz)	Measured sound absorption coefficient (α_s)		
	Sample 1	Sample 2	Sample 3
250	0.02	0.01	0.00
315	0.01	0.00	0.08
400	0.04	0.02	0.05
500	0.07	0.03	0.09
630	0.05	0.03	0.06
800	0.12	0.06	0.10
1000	0.09	0.07	0.10
1250	0.70	0.70	0.65
1600	0.55	0.63	0.60
2000	0.50	0.61	0.65
2500	0.63	0.65	0.60
3150	0.93	0.95	0.96
4000	0.70	0.70	0.59
5000	0.70	0.70	0.60

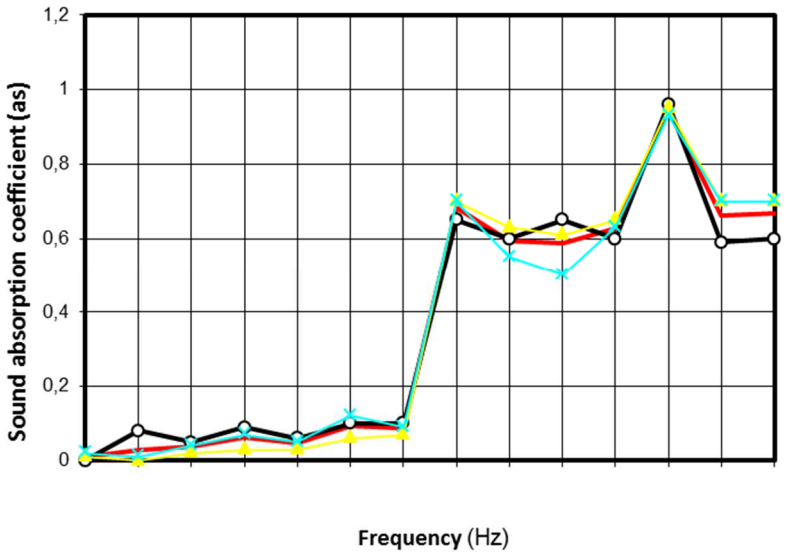

Figure 3.2. Graphical presentation of measured sound absorption coefficients

Table 3.2. Averaged sound absorption coefficient of BRIMEE, batch August 2016

Frequency (Hz)	Averaged sound absorption coefficient (α_s)
250	0.01
315	0.03
400	0.04
500	0.06
630	0.05
800	0.09
1000	0.09
1250	0.68
1600	0.59
2000	0.59
2500	0.63
3150	0.95
4000	0.66
5000	0.67

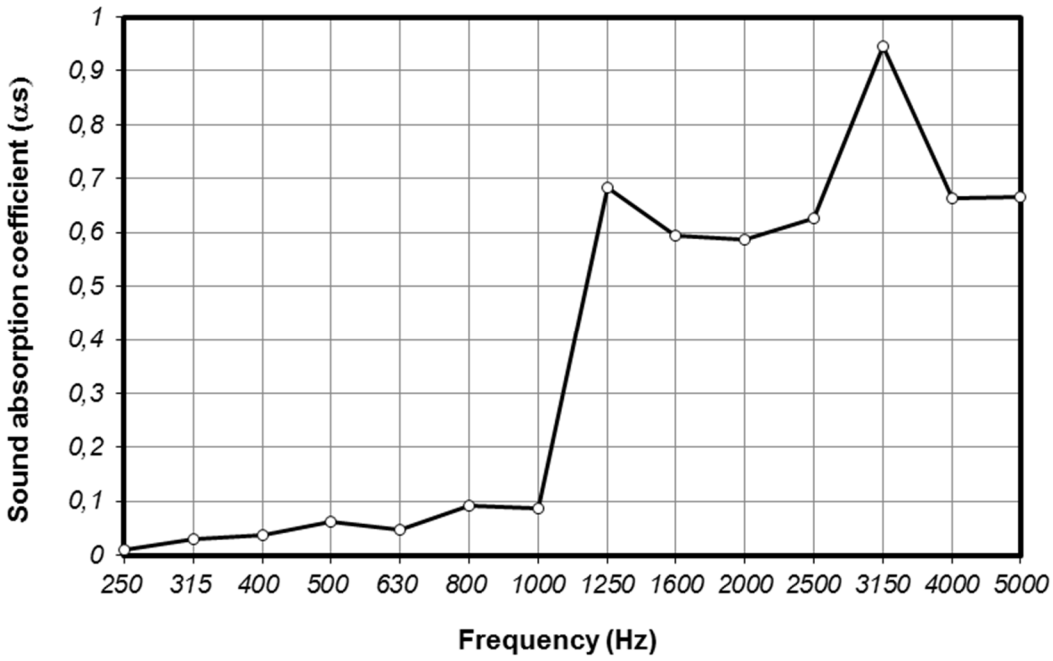

Figure 3.3. Graphical presentation of averaged sound absorption coefficients.

The results of the measured sound absorption coefficient on the BRIMEE samples from batch August 2016 are summarized in Table 3.1 and graphically presented on the graph (Figure 3.2). Furthermore, averaged sound absorption coefficients were calculated (Table 3.2) and graphically presented on the second graph (Figure 3.3).

The analysis of the measurements of sound absorption coefficient carried out on the same material showed the following results: at low frequencies (between 250 and 1000 Hz) this material has very low sound absorption coefficient, less than 10 %. The results of the averaged acoustic measurements also showed that between 1000 and 1250 Hz the sound absorption coefficient increases strongly and reaches around 60 %. At 3150 Hz the sound absorption coefficient is almost 100 %, but at higher frequencies it is again between 60 and 70 %.

4 Conclusions

Regarding the building-physics performances, the testing of BRIMEE white insulation core can provide indicative values for the BRIMEE ECO-innovative panel. The measurements and testing on BRIMEE NCC WHITE insulation, received in August 2016, performed at Slovenian National Building and Civil Engineering Institute (ZAG) included laboratory measurements for determination of thermal conductivity and laboratory measurements for determination of sound absorption coefficient.

The results of measurements and analysis on 2 boards of the BRIMEE insulation, received in August 2016, have shown that the thermal conductivity of this material is 0,035 W/mK. Therefore, the product can be classified as thermal insulation material in the range of thermal insulation materials that are available on the market.

The analysis of the measurements of sound absorption coefficient carried out on the BRIMEE insulation boards from August 2016 batch indicate that this material can be used in partition walls as a sound absorber in the high frequency region only.